

April 25, 1961

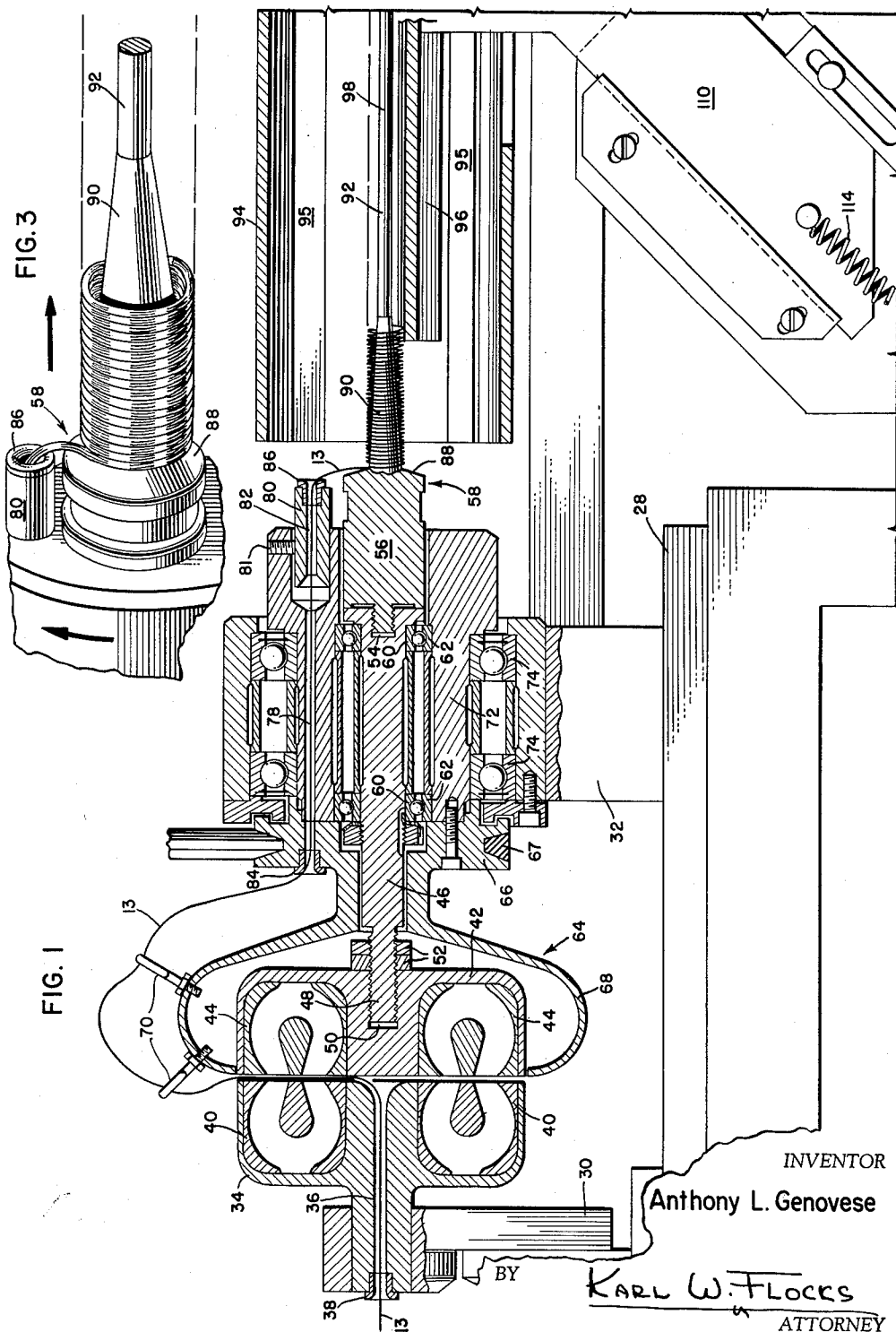
A. L. GENOVESE

2,980,959

CURLING FIBERS

Filed Jan. 17, 1958

4 Sheets-Sheet 1



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FIG. 4

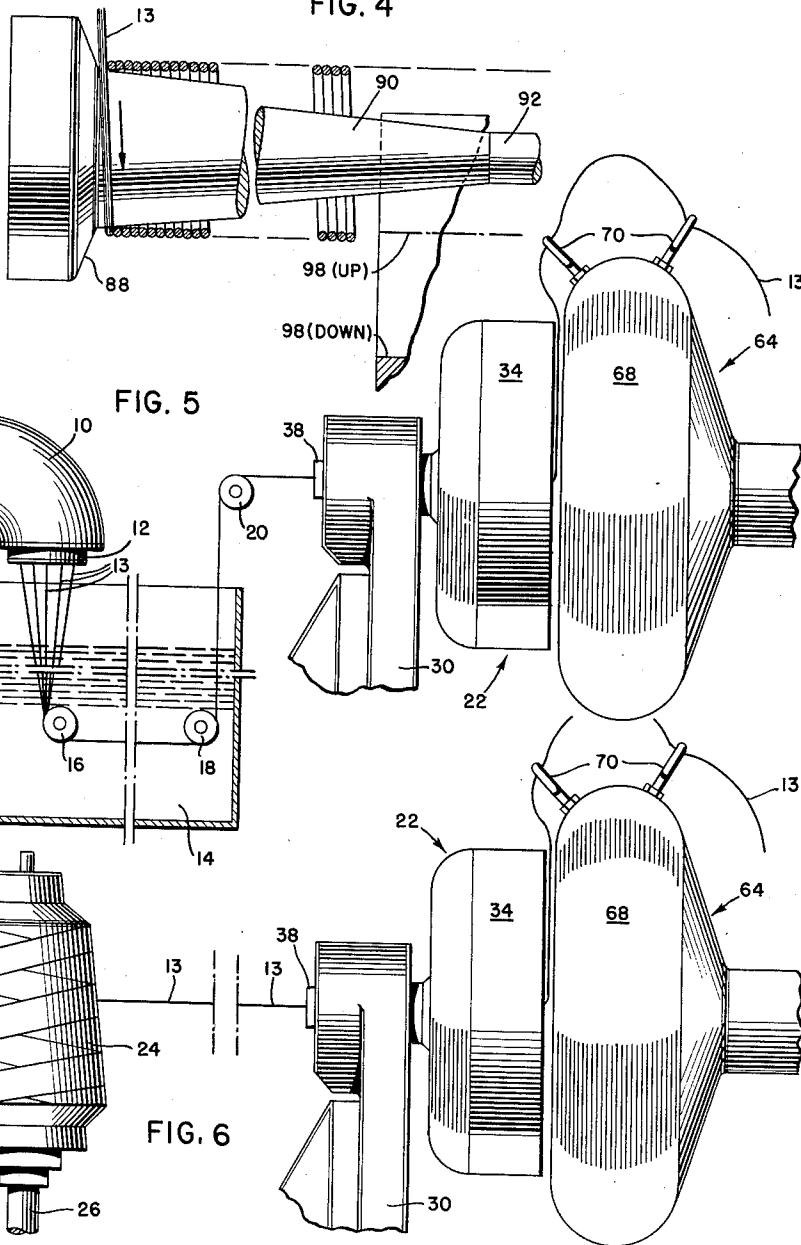


FIG. 5

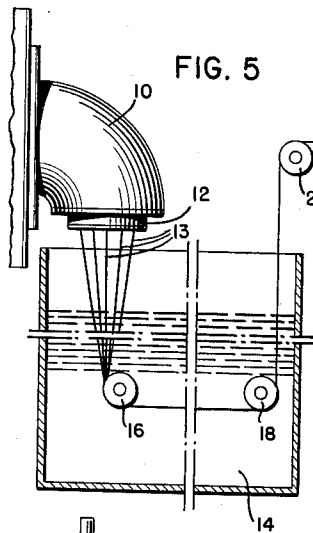
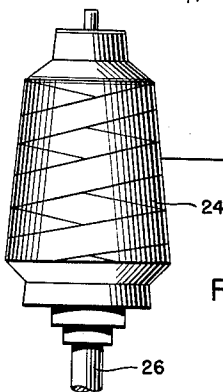


FIG. 6



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FIG. 7

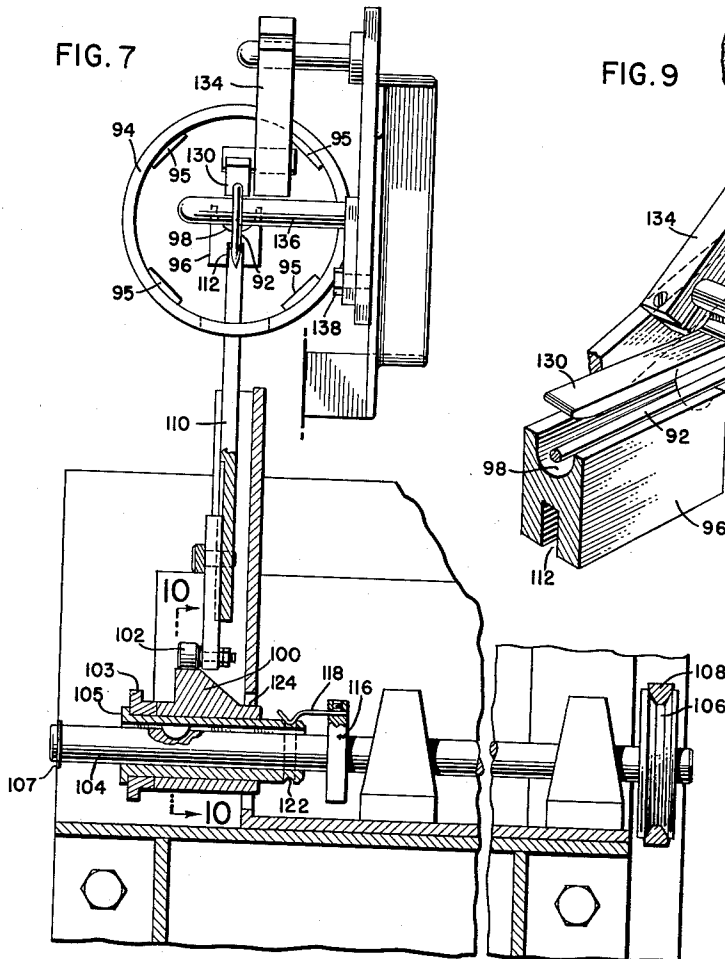


FIG. 9

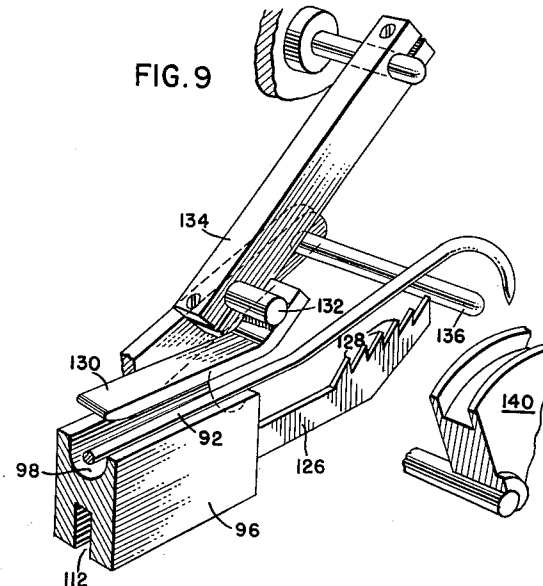


FIG. 8

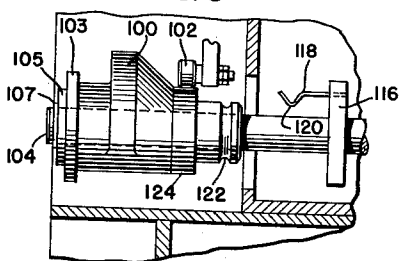
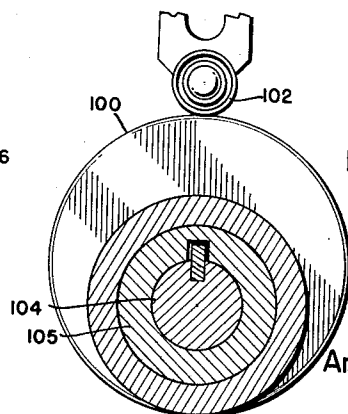


FIG. 10



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CURLING FIBERS

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Filed Jan. 17, 1958, Ser. No. 709,504

11 Claims. (Cl. 18—19)

The present invention relates to the production of curled fibers or filaments from polymeric material and more particularly to a novel method and apparatus for the production of continuous strands of curled fibers suitable for use as doll hair.

This application is a continuation-in-part of Genovese application Serial No. 637,495, filed January 31, 1957, and now abandoned.

Heretofore, various methods have been suggested for producing a curl in fibers of polymeric material such as polymeric vinylidene chloride, polyvinyl acetate, viscose fibers, and all thermoplastic fibrous materials. Mechanical crimping operations have been used in which the fibers are passed between knurled rolls. This method is not satisfactory for present purposes. Chemical treatments have been applied to some fibers for this purpose, however, in the case of certain resins, due to their resistance to attack by most chemicals and solvents, these methods are not generally applicable. The method currently in use for curling filamentary material for use as doll hair is to wind the material tightly onto a bobbin or other rigid support which is then immersed in a heating liquid at the desired temperature to set the curl therein. This method not only does not lend itself to continuous production of continuous lengths of material, but also during the setting of multi-filaments, there is a tendency for the individual filaments within the multi-filament strand to become integral and this detracts from the end appearance of the product.

For a suitable product for use as doll hair to give a satisfactory feel and appearance, it is essential that the multi-filaments within the curled material be free and readily separated. In the prior art methods, the multi-filaments are first twisted and the setting operation results in the setting of the twist therein so that the multi-filaments are not free to separate.

It is therefore the principal object of the present invention to provide a simple process and apparatus for the preparation of curled filaments from extrudable resins that are suitable for use as doll hair.

It is a further object of the present invention to provide a continuous process and apparatus therefor for the preparation of curled filaments having curls of uniform diameter.

It is a still further object of the present invention to provide a process and apparatus for the production of improved, curled filaments that may be utilized in connection with a conventional extruder without interference with the normal extrusion operation.

Another object of the invention is to provide a method and apparatus for producing improved curled filaments from multi-filamentary material, wherein the individual filaments in the curled material are free and readily separated from one another.

Other objects and the advantages of this invention will be apparent upon consideration of the following detailed description of a preferred embodiment thereof in conjunction with the annexed drawings, wherein:

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Fig. 1 is a longitudinal sectional view of a portion of the apparatus;

Fig. 2 is a similar view continued from Fig. 1 showing the balance of the apparatus;

Fig. 3 is a perspective view showing a portion of the mandrel;

Fig. 4 is an enlarged detail showing the winding of the filament on the mandrel;

Fig. 5 is a diagrammatic showing of a portion of the apparatus in combination with an extruder;

Fig. 6 is a diagrammatic showing of a portion of the apparatus being fed from a package of filaments mounted on a spindle;

Fig. 7 is a sectional view of the apparatus taken along the line 7-7 of Fig. 2;

Fig. 8 is a detail showing the cam assembly disengaged from the spring;

Fig. 9 is a perspective view of a portion of the application showing the discharge end of the mandrel;

Fig. 10 is a sectional view taken along the line 10-10 of Fig. 7;

Fig. 11 is a sectional view taken along the line 11-11 of Fig. 2; and

Fig. 12 is a similar view showing the trough in the down position.

The embodiment of the invention illustrated in the drawings is shown in conjunction with the production of curled filamentary material from polymeric vinylidene chloride resin, although it should be understood that the invention is applicable to any thermoplastic filamentary material such as acetate, nylon, polyester, vinyl resins, acrylics and the like as well as viscose rayon.

The term "polymeric vinylidene chloride" as used herein is intended to mean polymers, copolymers, and interpolymers of vinylidene chloride wherein the polymerized vinylidene chloride is present in predominant amount. Such polymeric vinylidene chloride may be obtained by polymerizing together monomeric vinylidene chloride with one or more other polymerizable materials such as vinyl chloride, vinyl acetate, styrene, acrylonitrile, the esters of acrylic or methacrylic acid, allyl and related esters of carboxylic or inorganic acids, unsaturated ethers, etc.

In producing fine fibers or filaments from polymeric material, it is the practice to extrude one or a number of filaments having a comparatively large diameter relative to the diameter desired in the finished filament. It is desirable to extrude the filaments or fibers of relatively large diameter and thereafter subject them to a stretching operation while still in a hot state to bring about a substantial reduction in the diameter of the filament. Thereafter, the filament is subjected to a cold drawing or stretching operation which further reduces its diameter and produces orientation along the fiber axes, resulting in a product having greatly enhanced strength properties.

Referring to the drawings, it can be seen that the curled multi-filaments may be produced continuously by extruding the molten resin in the usual manner as shown in Fig. 5 through an extruder 10 provided with a multi-perforated die 12 which extrudes a plurality of fibers 13 simultaneously. The fibers may be collected and oriented in the bath 14 about rolls 16, 18 and 20 and thence conducted to the curler represented by the numeral 22.

It should be noted that the curler 22 may be attached directly to a package 24 of wound filaments mounted on a spindle 26, as shown in Fig. 6.

The curler 22 is best illustrated in Fig. 1. The apparatus is mounted on a base 28 with supporting members 30 and 32 supporting the device. A cup-shaped casing 34 provided with a central passageway 36 therethrough

is securely mounted on the left supporting member 30. A small sleeve 38 is secured to the outer end of the passageway 36 to receive the filaments 13 entering the device. A plurality of magnets 40 are mounted in the casing 34 surrounding the passageway. Adjacent to the casing 34 is mounted a second cup-shaped casing 42, likewise provided with a plurality of magnets 44 which are in alignment with the magnets 40 and thereby prevent rotation of the casing 42 with respect to the casing 34.

A shaft 46 is provided with a threaded end 48 securely fastened to a threaded opening 50 in the casing 42 and locked thereto by lock nuts 52. A threaded opening 54 is provided in the opposite end of the shaft 46 into which is threaded the body portion 56 of mandrel assembly 58. A pair of bearing surfaces 60 are provided on the outer surface of the shaft 46 on which a pair of bearings 62 are adapted to be received. Surrounding the shaft 46 is a flier arrangement 64 rotating on the bearing 62. The flier arrangement 64 includes a pulley member 66 having an enlarged casing 68 integral therewith and surrounding the casing 42. A pair of eyelets 70 is attached to the casing 68 for guiding the filaments from the opening between the casings 34 and 42 around the outside of the casing 68.

The pulley member 66 is rotated by a belt 67 and is bolted to an annular member 72 which is adapted to rotate on the bearings 62 with respect to the shaft 46 and on a pair of bearings 74 surrounding it with respect to the frame member 32. A passageway 78 extends through the pulley member 66 and the annular member 72. The end of the passageway 78 opposite from the pulley is enlarged and adapted to receive an adjusting cylinder 80 provided with a passageway 82 therethrough. The end of the passageway 78 adjacent to the pulley is provided with a guide sleeve 84. The outer end of the passageway 82 is likewise provided with a guide sleeve 86.

The mandrel assembly 58 is located adjacent to the adjusting cylinder 80. The mandrel assembly includes the body portion 56 of an enlarged diameter tapering rapidly as shown at 88 to a gradually tapering section 90 extending therefrom. An extension 92 on the mandrel assembly 58 is screwed into a threaded opening in the tapered section 90 and consists of a long rod unsupported at its free end.

The mandrel assembly 58 is surrounded by a tube 94 which is insulated and surrounds a heating means 95. The heating means may be a spiral tubing conducting a heat medium or an electrical heating element as shown in Fig. 7, or any suitable heating means.

Adjacent the end of the tapering portion 90 of the mandrel assembly is mounted a reciprocating trough 96 which extends virtually the entire length of the heat tube 94. The trough 96 has a semi-cylindrical opening 98 therein extending the length of the trough along its upper surface. The diameter of the opening 98 in the trough is approximately equal to the diameter of the curl to be formed, and corresponds to the diameter of the mandrel at the curl forming point thereon. The trough 96 is reciprocated at a 45° angle to the travel of the fabricated curls. This is accomplished by a cam 100 and roller 102 arrangement as indicated. The cam 100 is mounted on a shaft 104 that is rotated by means of a pulley 106 and belt 108. The roller 102 is mounted on an extension member 110 which is attached to a slot 112 in the lower portion of the trough 96. A pair of springs 114 are provided to insure contact between the cam 100 and the roller 102. Thus, it can be seen that with each rotation of the shaft 104, the trough will be reciprocated once through the cam 100, roller 102 and extension 110. Integrally attached to the shaft 104 is a member 116 holding an engaging spring 118 having a bent portion 120 thereon adapted to engage an indentation 122 in the cam assembly. The cam assembly also is provided with a flat annular portion 124 adapted to receive the roller 102 when the cam assembly is shifted along the shaft 104, and the spring 118 is disengaged from the indentation

122. This permits the trough to stop reciprocating in its down position shown in Fig. 12.

At the end of the trough 96 a pusher member 126 extending forwardly therefrom is attached in the slot 112. The pusher member 126 is provided with a plurality of teeth 128 on its upper surface which are adapted to engage the curled material when the trough is at the upper end of its stroke.

The free end of the mandrel extension 92 may be bent upwardly beginning at the end of the heat tube 94 and then curved downwardly as best shown in Fig. 2. The pusher member 126 is located immediately below the upwardly bent portion of the mandrel extension.

Mounted over the mandrel extension 92 at the end of the heat tube 94 before the upwardly bent portion of the extension is a shoe member 130 supported by a rod 132 welded thereto which is adjustably supported by a support 134. The support 134 may be raised or lowered as necessary for the diameter of the curl being formed.

Immediately below the mandrel extension 92 near the end thereof is mounted a rod 136 adjustable in the vertical plane by the adjustment nut 138.

A pay-off wheel 140 rotated by a belt 142 may be provided immediately below the end of the mandrel extension 92, and a funnel 144 and packing cylinder 146 are located therebelow to receive the formed curled filaments. The packing cylinder 146 is continuously rotated by a pulley 148 and belt 150. The packing cylinder is likewise vibrated by a suitable vibrating means 152, such as a rotating eccentric.

Having described the apparatus, the method of operation will now be described.

Referring to Fig. 5, the molten resin in extruded from the extruder 10, through the multiperforated die 12 into a plurality of filaments 13 which are collected and oriented in the bath 14. The bundle of filaments 13 is then conducted through the central passageway 36 of the stationary casing 34, between the stationary casings 34 and 42 and thence through the eyelets 70 and around the enlarged casing 68 of the rotating flier arrangement 64. The bundle of filaments passes through the passageway 78 through the flier and out of passageway 82 in the adjusting cylinder 80 and thence to the stationary mandrel assembly 58. The filaments 13 are continuously wrapped around the tapered section 90 of the mandrel assembly due to the rotation of the flier with respect to the mandrel. Each successive wrap of the filaments on the mandrel acts to crowd the adjacent wrap outwardly and thereby causes the continuous movement of the coils of the helix formed by the wrapping action. The helical coils of filament move along the mandrel extension 92 within the heat tube 94 while being heated by the heating unit 95 to set the curl in the filaments. The reciprocating trough is continuously reciprocated at a 45° angle to the travel of the curls, such that at the upper limit of its travel, the semi-cylindrical opening 98 is in contact with the lower surfaces of the curls surrounding the mandrel extension. The trough serves a dual purpose. First of all, it acts to prevent the overlapping and telescoping of adjacent turns of the curl formed and yields a continuous, even movement along the mandrel extension. Also, by reference to Figs. 11 and 12 it can be seen that the trough is mounted a small distance (approximately $\frac{1}{16}$ "") off center from the mandrel assembly. In the winding of the filaments about the mandrel, in addition to the crowding action which results in a horizontal movement of the tightly packed helix along the mandrel, there is a slight rotation imparted to the helix. The off-center mounting of the trough enhances this rotation of the curl. The rotation of the helix acts to more uniformly set the curl therein.

As the helix approaches the end of the heat tube in its travel along the mandrel extension, the helix contacts the shoe member 130. Each reciprocation of the trough brings the upper surfaces of the helix into contact with

the shoe member and acts to break up any sticking together of adjacent turns of the helix as well as the various filaments within the multi-filamentary curled material.

The pusher member 126 at the end of the trough contacts the lower surface of the helix with each reciprocation of the trough and maintains even movement along the upwardly bent portion of the mandrel extension.

The rod 136 is mounted in close proximity to the mandrel extension and acts to squeeze the helix therebetween. The rod thus acts as a dam to retard flow and permit an even rate of travel over the end of the mandrel extension. The pay-off wheel 140 acts to uniformly pull the curled material downwardly from the mandrel extension and direct it through the funnel 144 and into the packing cylinder 146. The rotational and vibrational movement of the packing cylinder 146 causes the coils of filaments to pack neatly in a helical arrangement for shipping, storage and use.

During its travel through the heat tube, the curled material is heat set, so that after cooling, the curl remains in the material and when it is stretched to a straight filament and released, it snaps back into the curled form.

The shaft 104 is rotated at a constant speed, and as the parts rotate, the roller 102 travels along the cam surface 100 resulting in an up and down reciprocation of the trough in a 45° direction for a throw of approximately $\frac{3}{8}$ ". When the knob 103 on the cam assembly is pulled forward, the cam assembly disengages from the spring 118 and rides forward until the sleeve 105 hits the retaining ring 107 as best shown in Fig. 8. With the cam assembly in the position, the roller 102 is riding on a diameter 109 concentric with the shaft 104 and therefore the trough stops reciprocating. By disengaging the roller from the cam in this manner, the operator may clear off any material from the mandrel extension in case of an interruption in feeding.

This method and apparatus have been found particularly suitable for producing multifilaments of polymeric vinylidene chloride having nine fibers with a total denier of 1100 or 1300.

The position of the adjusting cylinder 80 may be adjusted by an adjusting nut 81 so that the filaments 13 issuing from the sleeve 86 thereon are properly aligned with the mandrel.

If desired, the filaments being extruded can be collected after orientation on a package and the curling operation performed at a later time. When curling filaments from the package, the filaments 13 are withdrawn from the package 24, as shown in Fig. 6, and are conducted directly to the central passageway 36 of the stationary casing 34, and the curl is imparted in the same manner.

The apparatus described for permitting rotation of the flier with respect to the mandrel, and for maintaining the mandrel assembly stationary is simple and yet permits a uniform winding of the curl onto the mandrel and a uniform crowding off of the successive turns to maintain the helix moving along the mandrel.

The initial wrapping of the filaments about the mandrel results in a tension on the filaments that is believed to impart a preliminary set to the curl, however, the subsequent heat treatment imparts a permanent set to the curl. Any method of heating is satisfactory so long as the filament temperature reaches the range of 180-210° F. The dwell time in the heat treating zone is relatively short, and after cooling a permanent curl is imparted to the filaments.

This method and apparatus for curling polymeric vinylidene chloride filaments has been found to be an extremely fast, continuous method which produces permanent curls of a uniform diameter without overheating of the resin. The curled multi-filament so produced is especially suitable for use as doll hair.

It will be obvious to those skilled in the art that vari-

ous changes may be made without departing from the spirit of the invention and therefore the invention is not limited to what is shown in the drawings and described in the specification but only as indicated in the appended claims.

What is claimed is:

1. A device for curling filamentary material comprising a rotating flier, a stationary mandrel assembly, means for rotating said flier with respect to said mandrel whereby filamentary material passing through said flier is continuously wrapped about said mandrel assembly in helical form and is moved therealong, said mandrel assembly comprising a mandrel portion at one end thereof adapted to receive said filamentary material, a relatively long mandrel extension attached to said mandrel portion, a reciprocating trough located immediately below said mandrel extension and extending the length thereof, means for reciprocating said trough to and from said mandrel extension whereby said trough is brought into contact with the lower surfaces of said helical shaped filamentary material with each reciprocation of said trough, and a heating means surrounding said mandrel assembly whereby said filamentary material is heated while travelling along said mandrel assembly in helical form.

2. A device in accordance with claim 1 wherein said trough is reciprocated along a path at an angle of 45° with respect to the direction of travel of said helical shaped filamentary material.

3. A device in accordance with claim 1 wherein the upper surface of said trough has an opening therealong of semi-cylindrical shape.

4. A device in accordance with claim 1 wherein the axis of said trough is slightly offset from the axis of said mandrel extension whereby the rotation of said helical shaped filamentary material during its travel across the mandrel extension is enhanced.

5. A device in accordance with claim 1 wherein a portion of said mandrel extension opposite from the end attached to said mandrel portion extends beyond said heating means, said portion being bent upwardly and then curved downwardly to the end thereof, a pusher member is attached to the end of said reciprocating trough for reciprocation therewith, said pusher member being located immediately below said upwardly bent portion of said mandrel extension and having an upward slope thereof corresponding to the slope of said upwardly bent portion of said mandrel extension.

6. A device in accordance with claim 1 wherein a shoe member is mounted immediately above said mandrel extension near the exit from said heating means whereby with each reciprocation of said trough, the upper surfaces of said helical shaped filamentary material are brought into contact with said shoe member thereby preventing the sticking together of the filaments.

7. A device in accordance with claim 1 wherein a rod is located immediately below said mandrel extension near the end thereof extending at right angles to the axis of said mandrel extension, said rod being located close enough to said mandrel extension so that it acts as a dam to retard the movement of said filamentary material between said mandrel extension and said rod.

8. A device in accordance with claim 7 wherein a rotating pay-off roll is located below the end of said mandrel extension whereby the filamentary material comes into contact with the rotating surface thereof to pull off successive turns of said helical material from between said rod and said mandrel extension.

9. A method of producing curled filamentary material from a continuous length of a bundle of filaments which comprises wrapping said bundle of filaments about a stationary mandrel to form a continuous helix of said material, continuously crowding said helix by the ensuing turns of said wrapping action to move said helix along said mandrel and from said mandrel, continuously and

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rhythmically tapping said helix of wound material along its bottom surface during its passage along said mandrel, and heating said helix while moving along said mandrel to set the curl so formed.

10. The method of claim 9 wherein at a point near the end of its travel along said mandrel and said heating, the helix of wound material is slightly compressed by bringing the upper portion of the helix into contact with a surface over the helix by said tapping action whereby the individual filaments in said helix that may have become stuck together are separated from one another.

11. The method of claim 9 wherein the tapping action is slightly offset from the axis of the mandrel whereby the rotation of the helix of said material with respect to the mandrel is enhanced by said tapping action during its travel along said mandrel.

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